HYDROGEOLOGICAL INVESTIGATION
FOR THE HAMLET OF MOFFAT
TOWN OF MILTON
THE REGIONAL MUNICIPALITY OF HALTON
PROJECT NO. PR-666

HYDROLOGY CONSULTANTS

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L.G. BRYCK, P. ENG.,
HYDROGEOLOGIST

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1.0 INTRODUCTION

A hydrogeologic investigation was authorized by the Regional Municipality of Halton to assist in determining the preparation of a secondary development plan at the Hamlet of Moffat.

The objectives of the investigation, as detailed in the attached terms of reference, were to evaluate the local groundwater quantity and quality and the recharge availability; and to establish the minimum lot sizes, phasing and testing requirements of future developments to prevent adverse effects on the groundwater system servicing the existing hamlet.

2.0 SUMMARY AND CONCLUSIONS

1) The principal aquifer in the Moffat study area is the dolomite bedrock, occurring under a thin, permeable overburden mantle serving as a storage reservoir. Local drilled wells have variable yields ranging from 9 litres/minute (2 gpm) to 110 litres/minute (25 gpm), dependent on the fracture distribution within the bedrock.

2) A water supply of 9 litres/minute (2 gpm) should be available from the combined well yield and system storage to provide the daily and peak water demand of a single-family residence. Thus, the bedrock wells may be defined as adequate domestic water sources.

3) The chemical quality of groundwater from the dolomite is suitable for domestic use throughout the study area. Treatment may be locally desirable for the control of high hardness and iron.

4) The sustained recharge to the bedrock aquifer is substantial, being about 7.0 m^3/day/hectare (630 gpd/acre), as established by the intensive monitoring study in the adjacent Blue Springs Creek basin.

5) The potentiometric surface developed for the bedrock aquifer suggests that the groundwater movement largely occurs through shallow flow systems, rather than a deep regional system, and that recharge availability is largely dependent on direct infiltration of precipitation.

6) The bedrock aquifer is highly vulnerable to surface pollutants, due to the shallow thickness and moderate permeability of the overburden. Detailed investigation of any proposed sludge and refuse disposal is essential to prevent groundwater contamination. Controlled operation and monitoring of existing pollution services, primarily road salt and petroleum products, should be considered to minimize the local pollution potential.

7) A minimum lot area of about 0.5 hectares (1.2 acres) for each residence in a development would be required to sustain the daily supply and dilution of a household by infiltrating precipitation.

8) Phasing of development is not required within the defined hamlet area; however, to minimize the potential impact, preference may be considered for the areas downgradient from the existing community.

9) Test drilling to assess groundwater availability would only be required to establish a communal well site. The cost of a successful 200 mm well extending to a depth of 60 metres is estimated to be about $12,000.

10) Field testing should be conducted by the developer prior to or as a condition of, draft subdivision approval to confirm the direction of groundwater movement, the potential impact on existing residences, the soil suitability for sewage systems and lot sizes for the development.

3.0 HYDROGEOLOGIC CONDITIONS

The groundwater conditions in the Moffat area were determined from a compilation of representative water-well information on file with the Ontario Ministry of the Environment, supplemented by geologic and hydrologic publications of provincial and federal agencies.

Field inspections were conducted to locate key hydrologic features and wells; to collect water samples; and to obtain information from local residents with regard to water availability and quality.

Discussions were held with staff of Public Health Department, and the Ministry of the Environment to identify current and past water-supply problems.

Map 1 shows the distribution of the water wells used to define the prevailing hydrogeologic conditions in the vicinity of the identified study area. Figure 1 illustrates the specific nature and distribution of the subsurface conditions within the study hamlet.

3.1 GEOLOGY

Bedrock

The bedrock occurring beneath Moffat entirely comprises grey, medium-crystalline crinoidal dolomite of the Silurian Amabel Group.

The bedrock surface is shown on Figure 2 to be undulating and sloping southward, with a deeply-incised depression extending through the hamlet in the vicinity of the railroad crossing.

Overburden

The surficial sediments, as shown on Figure 3, largely comprise sandy till of the Wentworth formation, with a sporadic veneer of outwash sand. The till formation has a general grain-size distribution of about 18 percent clay, 33 percent silt and 49 percent sand, indicative of moderate infiltration capacity. Well data indicate that the till formation extends to the bedrock surface.

The overburden thickness sediments is shown on Figure 4 to range from less than one metre in the westerly study area to over 10 metres in the vicinity of the defined bedrock depression. Variability of the overburden thickness is illustrated in the geologic section, Figure 1.

3.2 GROUNDWATER MOVEMENT

The static-water elevations of the local wells were plotted to prepare the groundwater contour map of the bedrock aquifer as shown on Figure 5.

The contours on the figure are lines of equal hydraulic potential from which the direction of groundwater movement may be determined, being normal to the contour lines from high to low potential. The configuration of the potentiometric surface shows that groundwater in the developed bedrock aquifer largely moves towards discharge to the local permanent streams.

The geologic section, Figure 1, illustrates that the movement of infiltrating precipitation is downward within the overburden towards the bedrock, and that groundwater within the bedrock moves laterally, with no indication of a significant upward component or a confining zone in the bedrock sequence.

Thus, it is deduced that the source of local groundwater recharge is largely derived from local infiltrating precipitation rather than lateral inflow from the upgradient area.

3.3 GROUNDWATER RECHARGE

The detailed multi-year investigation of the immediately adjacent Blue Springs Creek basin conducted by the Ministry of the Environment provided the key information for the analysis of the recharge availability to the bedrock aquifer system.

Within the major federal gauge sub-basin, comprising about 29 percent granular sediments at surface, the baseflow, or groundwater contribution, was determined to average about 730 m^3/day/km^2 (0.42 mgd/square mile) during the period of three water-years from 1966 to 1969. The adjacent Eden Mills sub-basin, which is physically similar to the study area, contains about 18 percent granular sediments and was determined during a comprehensive short-term monitoring period to have a baseflow of about 94 percent of the federal gauge basin. Applying this adjustment, it is estimated that the local groundwater recharge may be about 7.0 m^3/day/hectare (630 gpd/acre). This recharge is large,

compared to other areas in the province, and is attributable to the moderately high permeability of the predominant sandy till and the granular sediments and to the hummocky topography, which provided numerous catchment areas.

3.4 GROUNDWATER AVAILABILITY

Groundwater supplies are obtained from drilled wells penetrating the Amabel dolomite. The following table lists a summary of the yield and specific capacity information for wells in the immediate hamlet area and the surrounding region.

	Moffat	Region
Yield Range (l/min)	22 - 90	9 - 135
Mean Yield (l/min)	54.5	57.2
Specific Capacity Range (l/min/metre)	1.5 - 220	0.7 - 220
Mean Specific Capacity (l/min/metre)	48.5	32.3
Available Drawdown Range (metres)	3 - 20	2.5 - 30
Mean Available Drawdown (metres)	11.5	11.5

These well data demonstrate the availability of ample domestic supplies to individual drilled wells from the dolomite bedrock. Within the study region, no wells reportedly yielded less than 9 litres/minute (2 pgm), whereas 20 percent of the wells supply in excess of 90 litres/minute (20 gpm).

The presence of a heterogeneous fracture network is indicated within the bedrock sequence as no distinct relationship could be established between the reported well yields and aquifer penetration depths.

Figure 6 is a logarithmic probability plot for drilled bedrock wells, and illustrates the frequency occurrence of the reported specific capacities. Comparing the regional and local results, the bedrock fracture system appears to be better developed at Moffat than in the surrounding area.

3.5 GROUNDWATER QUALITY

Water samples were collected from drilled wells completed in the dolomite aquifer at Brookville and at Moffat. The analyses for the common chemical constituents are listed in the following table, together with results of the nearest sampled wells in the adjacent Blue Springs basin.

	Sample Location		
Constituents	Brookville School	Moffat Post Office	Blue Springs
Total Hardness ($CaCo_3$)	356	347	300-370
Total Iron (Fe)	0.10	0.84	0.02-1.0
Chloride (Cl)	287	31	10-45
Sulphate (SO_4)	73	52	30-50
Nitrate (N)	0.10	0.84	0-2
pH	8.1	8.0	7.3-7.7

(The above analyses except for pH, are expressed in milligrams/litres).

With the exception of chloride in the Moffat well, the analyses indicate that the groundwater is similar throughout the study region, being very hard and having low to moderate concentrations of iron, chloride, sulphate, and nitrate. The high chloride content at Moffat is not representative of the natural water quality and is believed due to pollution from a salt stock-pile, which is under current investigation by the Ministry of the Environment.

The groundwater has suitable chemical quality for domestic use but may require local treatment for control of the hardness and iron.

4.0 FUTURE DEVELOPMENT

4.1 HOUSEHOLD WELL YIELD

Assuming an average household of four persons, the daily household water requirement may be about 1.0 cubic metres (200 gallons) of which possibly two-thirds or 0.7 cubic metres (150 gallons) may be needed during the peak-hour period.

A well system may provide water directly from the well or from storage. Generally, about 0.15 cubic metres (30 gallons) may be available from a conventional storage facility, and a well would be required to deliver the remaining supply, being about 9 litres/minute (2 gpm) for a continuous period of one hour.

Recognizing the reported well yields and drawdown availability, abundant domestic water supplies are obtainable to drilled wells extending into the dolomite bedrock and equipped with deep-lift pumps.

4.2 WATER DEMAND

The water demand of a domestic residence comprises the external requirements for lawn watering and maintenance, and the internal requirements for drinking, washing and sewage disposal.

The external demand is essentially a function of the soil moisture deficiency, which may be about 100 mm (4 inches) during the summer period. Assuming that a lawn

area of about 0.2 hectares (0.5 acres) may be maintained at a typical residence, this consumptive water demand may amount to 0.47 m^2/day (100 gpd) average over the entire year.

The internal water demand has been established to average about 0.22 m^3/day (50 gpd) per resident or about 0.9 m^3/day (200 gpd) per residence, which is returned to the subsurface by means of the septic-tank system.

The effluent is largely renovated within a few feet of travel through the overburden following discharge from the tile bed by filtering, adsorption and bacterial die-off.

However, nitrate remains mobile in the effluent at a concentration of about 40 mg/l nitrogen, necessitating a 3:1 dilution to maintain the maximum drinking-water standard of 10 mg/l nitrogen.

Conservatively estimating that the entire nitrate loading reach the groundwater source, a water supply of about 2.7 m^3/day (600 gpd) would be needed to provide the dilution-water for a single domestic residence. Current literature indicates that the effluent nitrogen may be substantially reduced by denitrification within the soil, but as this cannot be substantiated for the hamlet area, a loading reduction has not been applied in the dilution calculations.

Combining the consumptive and dilution water demands, the daily water requirement of a residential lot is estimated to be about 3.2 cubic metres (700 gallons).

4.3 RESIDENTIAL LOT AREA

The sustained recharge availability should be adequate to provide the consumptive water withdrawal and to dilute the septic-system effluent within any new residential development.

The recharge has been assessed to largely occur as infiltrating precipitation, and the lot areas may be determined by relating the calculated water requirement to the deduced infiltrating recharge. Within the defined study area, the surficial sediments comprise sandy till, with a recharge capability of about 7.0 m^3/day/hectare (630 gpd/acre), and minimum residential lot areas of about 0.5 hectares (1.2 acres) would realistically appear feasible for subdivision developments in the hamlet.

4.4 DEVELOPMENT PHASING

Phasing of residential developments at Moffat is not essential provided that the lot areas are properly sized. The impact of residential development would be less significant from developments west of the Guelph Line where groundwater moves downgradient from existing residences, as shown on Figure 5.

5.0 POLLUTION SUSCEPTIBILITY

The Moffat study area may be classified highly vulnerable to pollution from surface contaminants, considering the moderate permeability of the overburden mantle and the relatively shallow depth of the bedrock aquifer.

Detailed hydrogeologic investigations will be essential prior to any continuous or large land disposal of sewage sludge; septic-system sludge and effluent; waste materials and refuse to establish the quality impact on the groundwater system.

Particular attention is required to ensure that present potential pollution sources, such as petroleum products from local service stations and salt from municipal storage areas, are routinely inspected and operated in a manner that would prevent the discharge of pollutants.

If practical, the application of road-salt during the winter maintenance period should be closely controlled to minimize the chloride buildup in the local bedrock aquifer.

6.0 TESTING

Adequate information is presently available to provide an overview of the groundwater soil conditions, and the potential impact of residential development at Moffat. Future testing to define site-specific conditions should be undertaken prior to or as a condition of draft subdivision approval.

6.1 WATER SUPPLY

The availability of potable domestic supplies from the dolomite bedrock is well established; however, testing would be required to confirm a communal-well source.

As similar yield potential is indicated throughout the study area, such wells should ideally be located remote from existing residences and roads to minimize interference and pollution problems.

Yields exceeding 500 litres/minute would be anticipated from deeper bedrock wells, as obtained at the nearby municipalities of Acton, Rockwood, Guelph and Campbellville.

Assuming a total depth of about 60 metres, a successfully completed 200 mm communal well, including materials, pumping test and supervision, may cost about $12,000. based on local unit prices for a recently completed subdivision well.

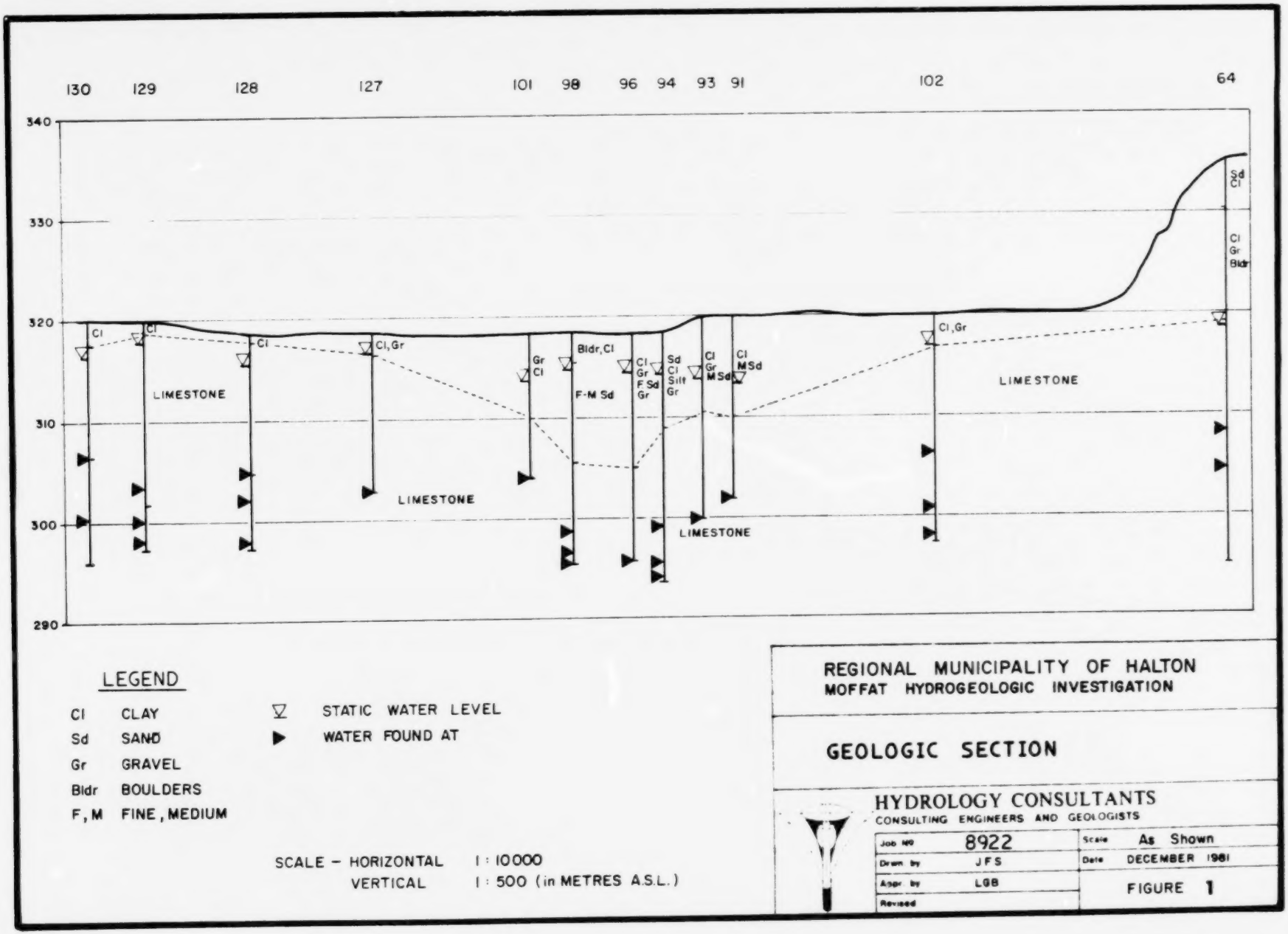
6.2 SEWAGE EFFLUENT

Testing of the overburden and/or bedrock should be undertaken by the developer, with a density of about one test-site/four hectares (10 acres) and a minimum of three test-sites for any subdivision to establish the soil suitability for septic-tank systems and the quality of impact on the local physical conditions, but should be sufficiently detailed to determine the overburden thickness and permeability, and the groundwater vertical and horizontal gradients; and to confirm the subsurface capability to receive and assimilate sewage effluent and the subdivision lot areas.

Respectfully Submitted,
HYDROLOGY CONSULTANTS

Leon G. Bryck, P. Eng.,
Hydrogeologist

FIGURES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Bldr
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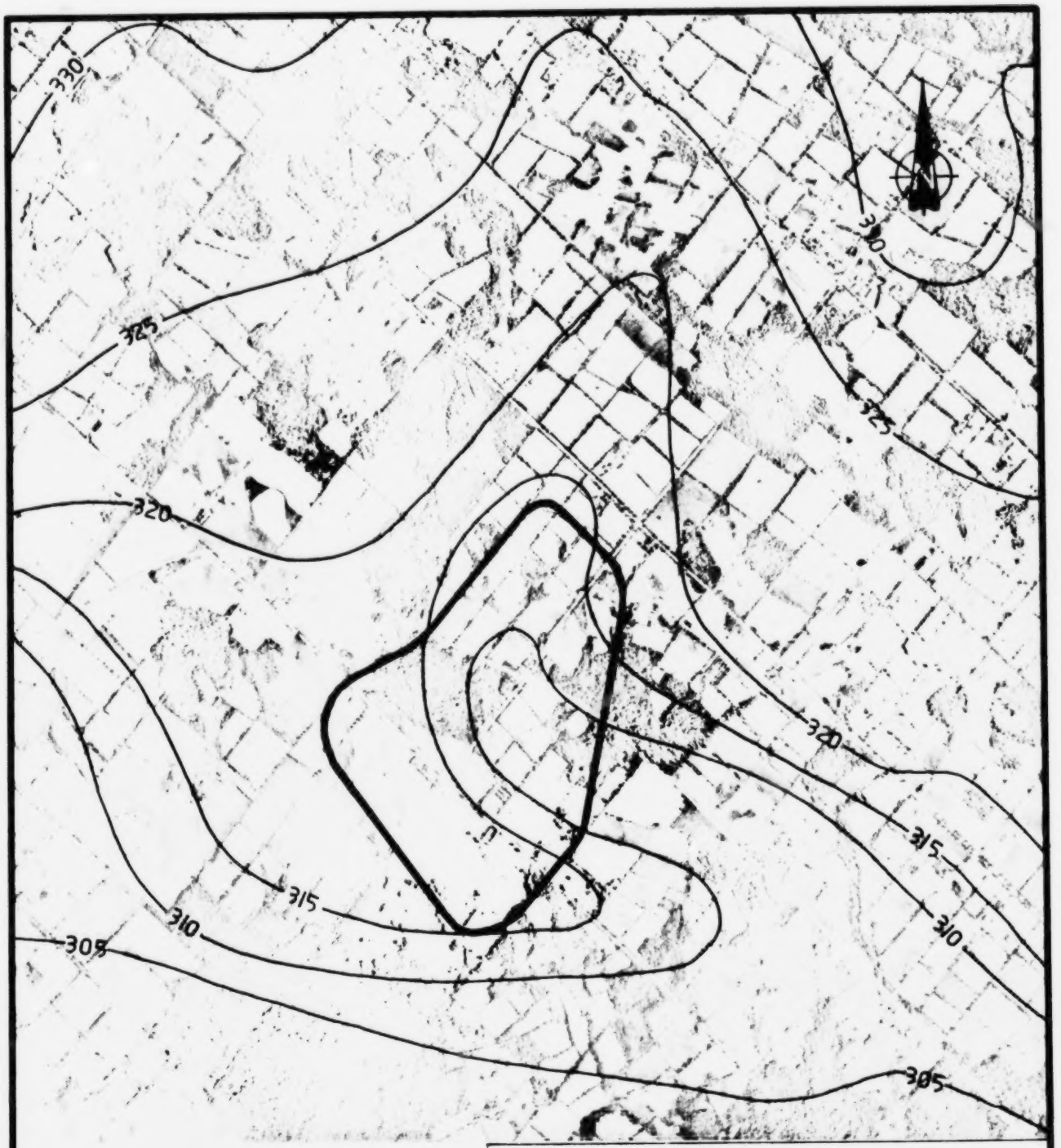
LIMESTONE
LIMESTONE
LIMESTONE
LEGEND
Cl CLAY
Sd SAND
Gr GRAVEL
Bldr BOULDERS
F, M FINE, MEDIUM
STATIC WATER LEVEL
WATER FOUND AT
SCALE – HORIZONTAL 1 : 10000
VERTICAL 1 : 500 (in METRES A.S.L.)
REGIONAL MUNICIPALITY OF HALTON
MOFFAT HYDROGEOLOGIC INVESTIGATION
GEOLOGIC SECTION
HYDROLOGY CONSULTANTS
CONSULTING ENGINEERS AND GEOLOGISTS
Job No 8922
Scale As Shown
Drawn by J F S
Date DECEMBER 1981
Appr by L G B
Revised
FIGURE 1



STUDY AREA

BEDROCK CONTOUR
(in METRES A.S.L.)

REGIONAL MUNICIPALITY OF HALTON
MOFFAT HYDROGEOLOGIC INVESTIGATION

BEDROCK TOPOGRAPHY

HYDROLOGY CONSULTANTS
CONSULTING ENGINEERS AND GEOLOGISTS

Job No	8922	Scale	1: 25 000
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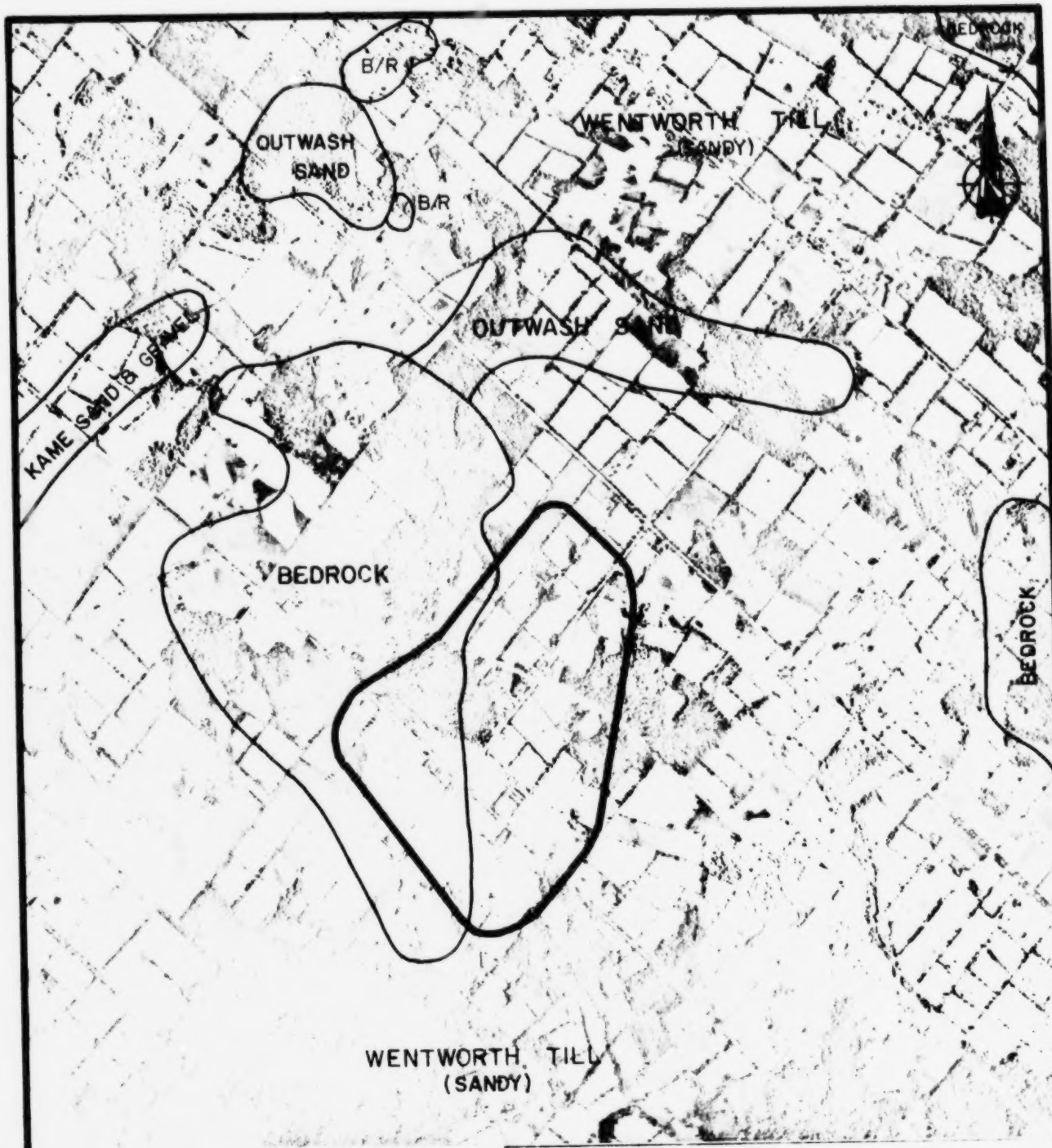

STUDY AREA

REGIONAL MUNICIPALITY OF HALTON
MOFFAT HYDROGEOLOGIC INVESTIGATION

SURFICIAL GEOLOGY

HYDROLOGY CONSULTANTS
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Job No	8922	Scale	1:25 000
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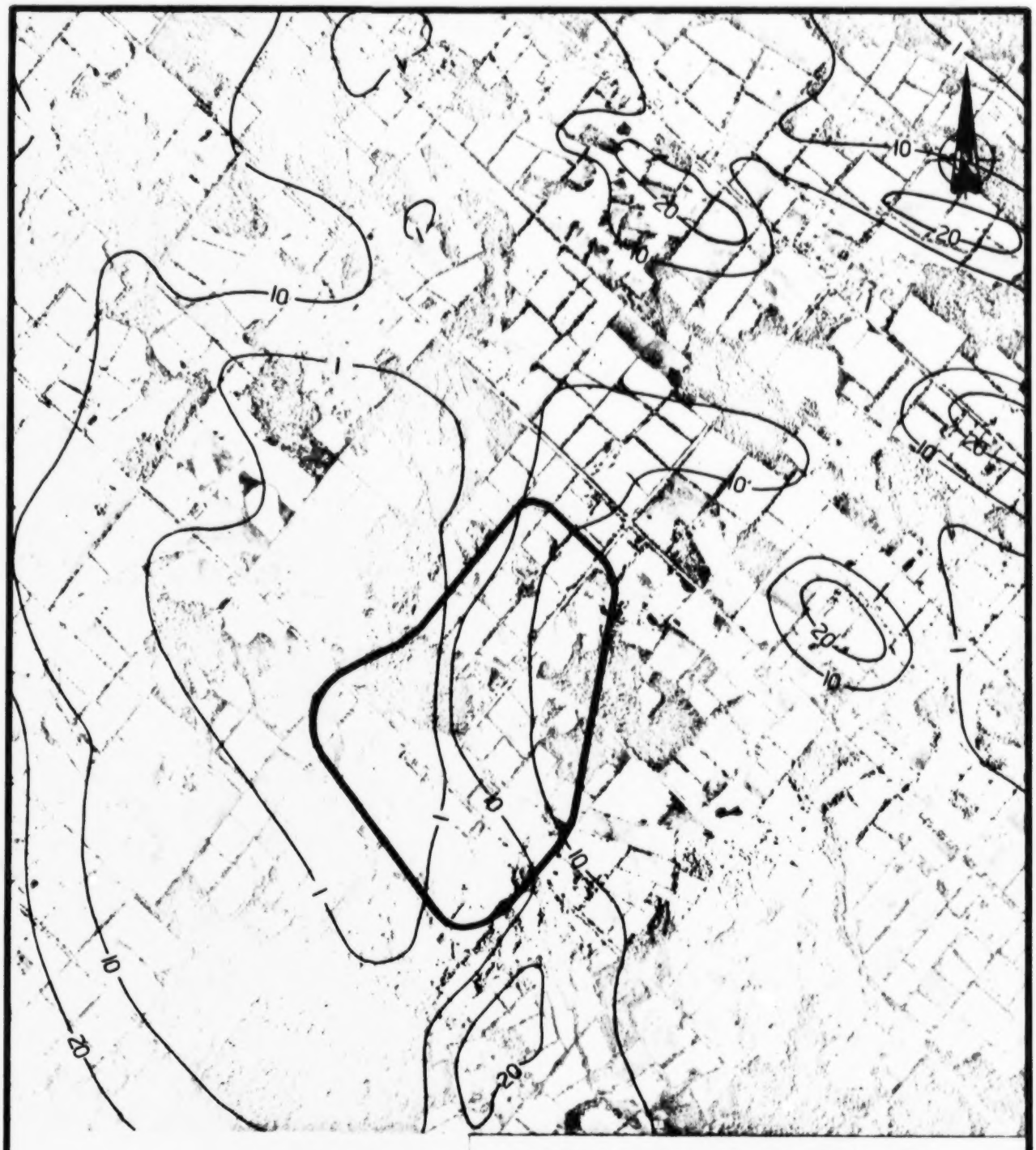
Appr by	LGB		
Revised			FIGURE 3



STUDY AREA

LINE OF EQUAL OVERBURDEN THICKNESS (ISOPACH) - in METRES

REGIONAL MUNICIPALITY OF HALTON
MOFFAT HYDROGEOLOGIC INVESTIGATION

OVERBURDEN THICKNESS

HYDROLOGY CONSULTANTS
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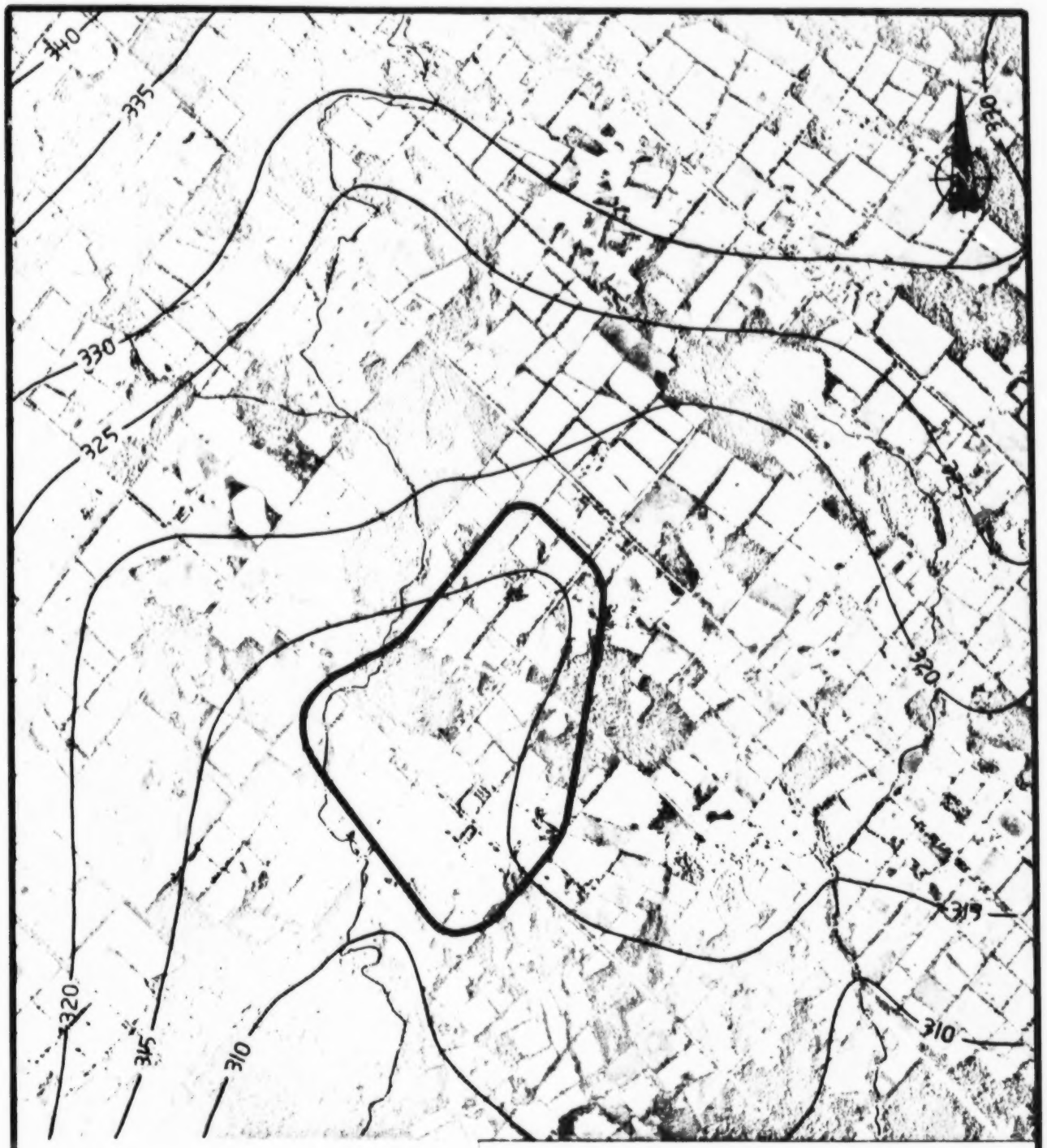
Job No	8922	Scale	1:25 000
Drawn by	JFS	Date	DECEMBER 1981
Appr by	LGB		
Revised		FIGURE	4



STUDY AREA

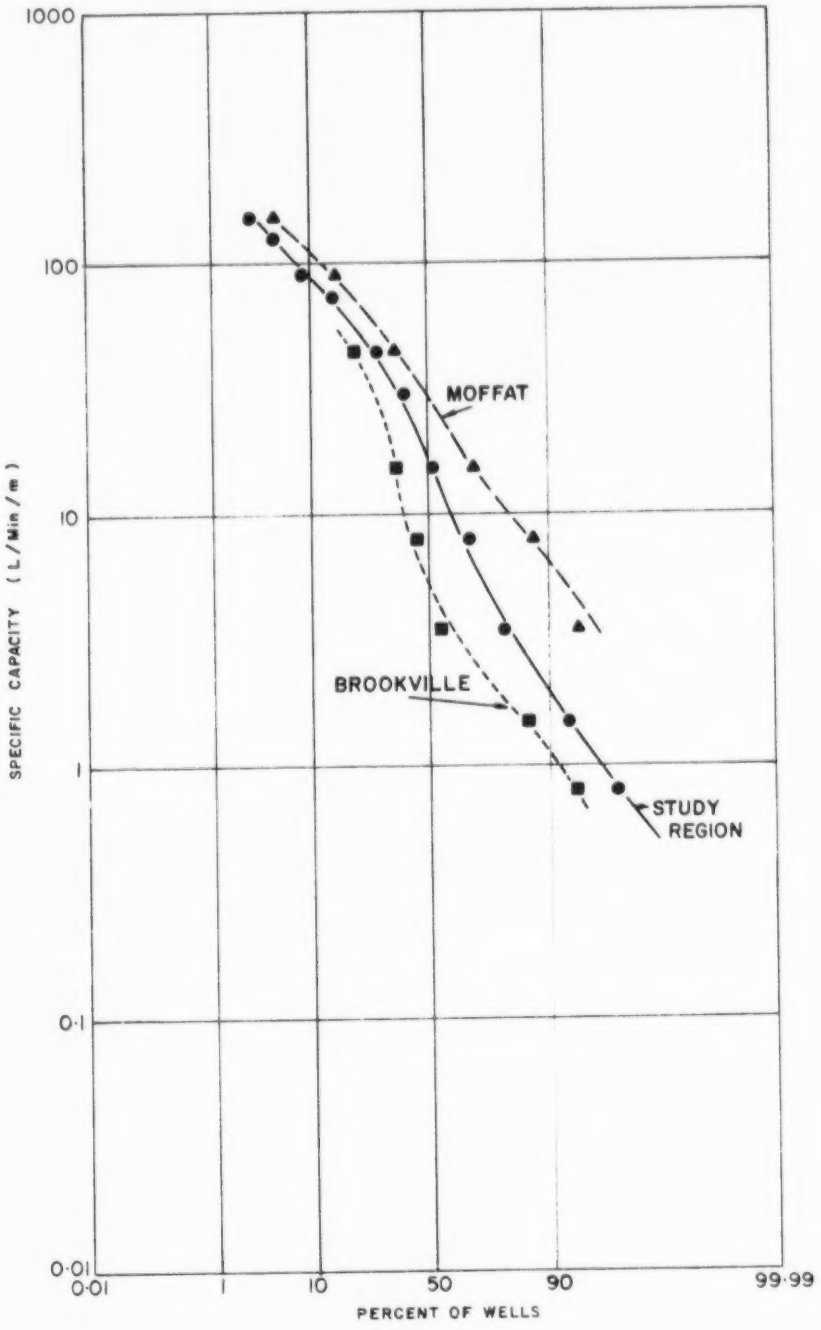
WATER - LEVEL CONTOUR
(in METRES A.S.L.)

REGIONAL MUNICIPALITY OF HALTON
MOFFAT HYDROGEOLOGIC INVESTIGATION

WATER - LEVEL CONTOURS IN THE BEDROCK

HYDROLOGY CONSULTANTS
CONSULTING ENGINEERS AND GEOLOGISTS

Job No	8922	Scale	1 : 25 000
Drawn by	JFS	Date	DECEMBER 1981
Appr by	LGB		FIGURE 5
Revised			



SPECIFIC - CAPACITY vs FREQUENCY
GRAPH FOR BEDROCK WELLS

FIGURE 6

APPENDIX A: Representative Water Well Data

NOTES

1) Data provided in this Appendix are listed as shown in the Ministry of the Environment files. Measurements in feet may be converted to metres by multiplying by 0.3048 and measurements in gallons per minute may be converted to litres per minute by multiplying by 4.5.

2) Reference in the following well logs to "limestone", should correctly be read as "dolomite".

REPRESENTATIVE WELL RECORDS
REGIONAL MUNICIPALITY OF HALTON (MILTON)

Well Number	Quality	Static Level (ft)	Pumping Level (ft)	Test Rate (gpm)	Test Duration (hrs)	Geologic Log (ft)
1	Fresh	18	35	15	4	Brown clay 7;grey clay stones 27; limestone 74.
2	Fresh	4	10	12	1	Clay gravel 8; grey limestone 58.
3	Fresh	11	41	4	1	Medium sand, boulder 13;grey limestone 30; blue limestone 41.
4	Fresh	20	20	7	3	Topsoil 3; clay, boulder 64; gravel 70.
5	Fresh	12	25	8	2	Topsoil 3; grey limestone 57.
6	Fresh	15	15	8	6	Grey limestone 58.
7	Fresh	8	10	10	1	Clay, gravel 7; grey limestone 25; blue limestone 40.
8	Fresh	12	15	8	2	Gravel,stones,clay 8; grey limestone 60.
9	Fresh	6	36		1/20 min	Brown silt, stones, gravel 6; grey limestone 40.
10	Fresh	30	90	6	2	White limestone 42; grey limestone 118.
11	Fresh	15	20	30	2	Brown clay, boulder 16; brown shale 18; brown limestone 36; grey limestone 70; white limestone 77.
12	Fresh	12	19	20	1	Brown clay 5; grey limestone 51.
13	Fresh	20	65	25	3	Brown clay, medium sand 2; limestone 70.
14	Fresh	7	15	10	2	Gravel, clay 6; white limestone 40; grey limestone 73.
15	Fresh	4	59	6	1	Brown silt 7; grey clay, boulder, gravel 50; grey limestone 55; blue dolomite 64.
16	Fresh	Flow	15	15	2	Previously dug 5; clay, boulder 7; gravel, clay 20;boulder 22;gravel clay 38;grey rock 76.
17	Fresh	7	10	15	3	Topsoil 2;brown clay, gravel 9; grey clay 24; grey limestone 42; blue limestone 65.

Well Number	Quality	Static Level (ft)	Pumping Level (ft)	Test Rate (gpm)	Test Duration (hrs)	Geologic Log (ft)
18	Fresh	7	60	25	3	Gravel, medium sand 35; limestone 82.
19	Fresh	28	34	15	/30 min	Brown clay, stones 35; brown clay, gravel 54; grey gravel 95; grey limestone 124.
20	Fresh	28	44		1/30 min	Previously dug 31; grey clay, boulder 40; grey limestone 52.
21	Fresh	20	38	5	2	Gravel, clay 25;black limestone, clay 30; black limestone 50; grey limestone 69.
22	Fresh	20	20	20	3	Previously dug 17; limestone 77.
23	Fresh	8	18	15	1	Brown clay, stones 25; brown clay, gravel 34; grey rock 75;grey rock 85;grey rock 92.
24	Fresh	6	9	15	4	Brown stones, clay 18; blue rock 38.
25	Fresh	17	65	4	1	Brown clay, boulder 11; grey clay, boulder 31; grey limestone 65.
26	Fresh	10	15	25	2	Clay 10; medium sand, clay 25;gravel clay 35; grey limestone 55; brown limestone 65 blue limestone 123.
27	Fresh	20	40	15	5	Brown clay 18; clay, medium sand, boulder 40; hardpan 45; limestone 76.
28	Fresh	11	15	15	4	Brown clay, boulder 14; brown gravel, clay 24; grey rock 61.
29	Fresh	34	60	10	1	Topsoil 1;brown clay, stones 23; grey clay, gravel 65;grey rock 117.
30	Fresh	10	55	10	1/20 min	Brown clay, boulder 23;grey clay, boulder 40; brown silt clay, gravel 57;grey limestone 69.
31	Fresh	3	40	10	2	Grey clay 15;grey clay, gravel, boulder 24; limestone 26;grey limestone 40.
32	Fresh	13	50	7	1	Brown silt 6;grey clay, boulder 40; grey limestone 55; blue shale 57.
33	Fresh	16	28	7	5	Boulder, gravel 10; limestone 40.

Well Number	Quality	Static Level (ft)	Pumping Level (ft)	Test Rate (gpm)	Test Duration (hrs)	Geologic Log (ft)
34	Fresh		7	25	1	Brown clay,sand 7;grey limestone 19;grey limestone 38.
35	Fresh		26	25	1	Brown sand, silt 11;grey clay 18;grey limestone 48;green limestone 52.
36	Fresh	Flow	30	12	1	Brown clay, stones 10;blue rock 25;grey rock 65.
37	Fresh	11	23		1	Brown clay, gravel 5;grey rock, limestone 10; grey limestone 52.
38	Fresh	5	31	27	1	Yellow limestone 7;grey limestone 10;blue limestone 40.
39	Fresh	35	37	15	1	Brown clay, stones 27;grey limestone 93.
40	Fresh	12	15	25	1	Brown clay 10;grey limestone 43.
41	Fresh	10	58	8	1	Brown clay, silt 17; grey clay 28;grey limestone 65.
42	Fresh	54	60	20	1	Brown clay,gravel,boulder 28;grey clay,gravel boulder 51;green limestone 64;grey limestone 84.
43	Fresh	21	57	10	1	Brown silt 2;grey limestone 5;grey limestone 64.
44	Fresh	100	100	10	1/30 min	Grey clay, gravel,boulder 25;grey clay,gravel 78; grey limestone 132.
45	Fresh	26	32	10	/3C min	Topsoil,medium sand 8;gravel,boulder 20;blue limestone 35;white limestone 71;brown limestone 73.
46	Fresh	15	35	5	5	Clay, medium sand 8;limestone 42.
47	Fresh	28	40	4	2	Gravel, clay 25;gravel, medium sand, clay 52; black limestone 72;grey limestone 105.
48	Fresh	12	29	10	3	Previously dug 21;grey clay, gravel, boulder 40; limestone 51.
49	Fresh	25	55	5	2/30 min	Brown gravel 20;brown medium sand, clay 35; black stones, clay 45;black limestone 79;black rock 89.

Well Number	Quality	Static Level (ft)	Pumping Level (ft)	Test Rate (gpm)	Test Duration (hrs)	Geologic Log (ft)
50	Fresh	16	35	15	6	Clay, gravel, stones 74;blue rock 132.
51	Fresh	19	23	6	/30 min	Clay stones 40;grey limestone 70; black limestone 102.
52	Fresh	15	20	15	1	Clay, gravel 20;stones, clay 25;black limestone 55;grey limestone 104.
53	Fresh	43	48	15	1	Topsoil 1;brown clay, stones 35;brown clay, gravel 58;grey limestone 143.
54	Fresh	49	55	15	1	Topsoil 1;brown clay, stones 43;brown limestone 65;grey limestone 143.
55	Fresh	45	60	10	1	Clay stones 42;brown rock 90;white rock 144.
56	Fresh	55	100	4	2	Clay stones 20;gravel, clay, stones 59; black limestone 110;grey limestone 130;white limestone 140.
57	Fresh	7	69	2	1	Brown clay, boulder 24;grey limestone 69.
58	Fresh	13	14	10	1	Brown overburden 2;brown sand, gravel, stones 13; black rock 25;grey rock, stones, shale 38; grey rock 45;grey limestone 90.
59	Fresh	12	15	15	2	Clay, gravel 23;medium sand 33;limestone 65.
60	Fresh	20	50	15	6	Topsoil 1;brown clay, stones 50;blue rock 110; blue rock 125.
61	Fresh	82	86	10		Red clay, stones 104;blue rock 115;grey rock 156.
62	Fresh	8	12	10	1/15 min	Brown silt, boulder 12;grey clay, boulder 17; grey clay, gravel 19;grey limestone 36; blue dolomite 44.
63	Fresh	60	70	15	4	Previously dug 23;clay stones, gravel 56; brown limestone 90;blue limestone 132.
64	Fresh	55	55	25	1	Brown sand, clay 16;grey clay, gravel, boulder 53;blue rock 57;blue limestone 69;grey limestone 121.
65	Fresh	59	70	12	1	Previously dug 80;grey limestone 120.

Well Number	Quality	Static Level (ft)	Pumping Level (ft)	Test Rate (gpm)	Test Duration (hrs)	Geologic Log (ft)
66	Fresh	50	80	1	2	Gravel, clay 30;medium sand, gravel 44;grey limestone 80.
67	Fresh	85	95	15	1/15 min	Topsoil 1;brown clay, stones 73;brown rock 130;grey rock 172.
68	Fresh	21	78	3	1/30 min	Brown clay, gravel, boulder 26;grey clay, boulder 36;grey limestone 74;blue dolomite 78.
69	Fresh	67	86	8	1	Previously dug 30;brown clay, boulder 62;grey limestone 86;dolomite 102.
70	Fresh	13	27	8	2	Brown gravel, medium sand 2;brown limestone 30.
71	Fresh	7	11	12	1	Topsoil 1;brown limestone 15;blue limestone 27; brown sand 40.
72	Fresh	13	16	20	1	Topsoil 1;brown clay stones 8;brown rock 25; grey rock 99;brown rock, shale 116.
73	Fresh	22	26	18	1	Brown silt 4;grey limestone 49.
74	Fresh	7	15	4	2	Clay 5;grey limestone 54.
75	Fresh	47	58	6		Brown clay, stones 12;clay, medium sand 26;quick sand 45;limestone 67.
76	Fresh	25	25	20	1	Brown clay, gravel, sand 21;brown clay, gravel 41;grey clay, gravel 59;brown limestone 73.
77	Fresh	24	73	7	1/30 min	Brown clay, boulder, gravel 33;grey clay, boulder, gravel 50;grey limestone 55;black shale 68; black rock 75;grey rock 82.
78	Fresh	10	10	10	1	Brown topsoil 1;brown sand 6;brown sand,hardpan, gravel 56;grey limestone 140.
79	Fresh	11	60	20	4	Brown clay, stones 60;gravel 73.
80	Fresh	5	25	20	1	Brown clay, boulder 11; grey clay 24;grey clay, boulder, gravel 40;brown limestone 49.
81	Fresh	19	24	12	1	Brown clay stones 30;grey clay, sand, gravel 50; hardpan, gravel 54;black rock 61.

Well Number	Quality	Static Level (ft)	Pumping Level (ft)	Test Rate (gpm)	Test Duration (hrs)	Geologic Log (ft)
82	Fresh	29	64	10		Brown clay 21;grey clay 29;black slate 44; grey limestone 71.
83	Fresh	20	26	5	2	Previously dug 14;brown medium sand 32;limestone 45.
84	Fresh	13	64	7	1	Brown topsoil, clay, boulder 15;grey clay, boulder 31; grey limestone 64.
85	Fresh	9	32	10	2	Silt 2;brown clay, boulder 14;limestone 30; blue dolomite 40.
86	Fresh	12	38	15	1	Silt 1;brown clay, medium sand, boulder 13;grey limestone 44.
87	Fresh	3	31	30	1	Brown silt 10;grey limestone 54.
88	Sulphur	15	40	5	3/30 min	Clay, stones 14;black limestone 50;blue limestone 95.
89		22	25	10		Brown rock, dark clay 18;grey rock 25;blue rock 50.
90	Fresh	8	33	2	1	Brown loose sand 5; hard, grey limestone 35.
91	Fresh	22		15		Gravel, clay, medium sand 33; limestone 60.
92	Fresh	20		10		Gravel, clay, medium sand 44; limestone 64.
93	Fresh	20		10		Previously dug 20;clay,gravel,medium sand 31; limestone 66.
94	Fresh	14	20	10	1	Brown sand, clay 20;brown clay, silt 30;brown gravel, stones 32;grey limestone 82.
95	Fresh	12	22	5	1/30 min	Clay 10;medium sand 25;limestone 72.
96	Fresh	10	10		1	Clay, gravel, quicksand 44;limestone 75.
97	Fresh	16	20	15	1	Gravel, medium sand, clay 24;grey limestone 63.
98	Fresh	12	20	10	1	Boulder, clay 10;medium sand, quicksand 43; grey limestone 76.
99	Fresh	8	12	9	3	Brown sand 10;blue clay, silt 30;brown gravel, sand 40;black rock 60.

Well Number	Quality	Static Level (ft)	Pumping Level (ft)	Test Rate (gpm)	Test Duration (hrs)	Geologic Log (ft)
100	Fresh	14	16	15	2	Black limestone, shale 55;white limestone 79.
101	Fresh	15	15	15		Gravel,clay 28;limestone 48.
102	Fresh	10	15	15	2	Clay, gravel 11;blue limestone 40;grey limestone 75.
103	Fresh	29	30	10	1/30 min	Brown clay, sand, boulder 19;white limestone 90.
104	Fresh	25	30	18	2	Brown clay, gravel, stones 17;grey limestone 60; blue limestone 97.
105	Fresh	12	40	15	1	Brown clay, gravel, stones 22;grey limestone 38; white limestone 54.
106	Fresh	7	10	25	1	Brown silt 8;grey limestone 38.
107	Fresh	11	49	2	2	Medium sand, boulder 35;grey limestone 42; blue limestone 49.
108	Fresh	18	32	10	1/30 min	Clay, gravel 13;grey limestone 42.
109	Fresh	14	16	10	1	Boulder, gravel 24;grey limestone 51.
110	Fresh	9	34	10	1/30 min	Topsoil 1;clay, gravel 10;grey limestone 40.
111	Fresh	15	25	20	1	Topsoil 1;clay, stones 12;medium sand, gravel 16;grey limestone 59.
112	Fresh	53	57	15	2	Brown clay, stones 95; blue rock 115;grey rock 145.
113	Fresh	70	75	15	3	Topsoil 1;stones, clay 84;brown rock 95.
114	Fresh	44	54	10	1	Previously dug 5;brown clay, stones 30;brown clay, gravel 80;hardpan, gravel 82;brown rock 98.
115	Fresh	27	29	10	2	Brown clay, boulder, gravel 38;limestone 46.
116	Fresh	68	110	5	2	Brown clay, boulder 52;grey clay, gravel 110; brown sand, gravel 113;grey clay, gravel 117.
117	Fresh	7	8	15	1/15 min	Brown clay 3;black limestone 50;grey limestone 55.
118	Fresh	17	20	10	2	Topsoil 2;black limestone 42;grey limestone 71.
119	Fresh	16	60	10	1	Brown clay,boulder 15;grey clay, silt 45;grey gravel,clay 48;grey clay,gravel 67;brown limestone 71.

Well Number	Quality	Static Level (ft)	Pumping Level (ft)	Test Rate (gpm)	Test Duration (hrs)	Geologic Log (ft)
120	Fresh	8	15	20	2	Black limestone 40;grey limestone 72.
121	Fresh	8	25	15	1	Medium sand 8;clay 23;limestone 76.
122	Fresh	4	22	15	1	Brown clay 15;grey clay, gravel 55;brown limestone 61.
123	Fresh	27	28	15	1/30 min	Brown topsoil 2;black rock 45;black rock 55; grey limestone 59.
124	Fresh	22	70	5	2	Topsoil 1;grey limestone 102.
125	Fresh	6	10	5	1/30 min	Clay 2;black limestone 40;grey limestone 60.
126	Fresh	12	14	15	2	Grey clay 4;black limestone 42;grey limestone 51.
127	Fresh	6	6		1/30 min	Clay, gravel 7;black limestone 52.
128	Fresh	10	20	15	2	Clay 3;black limestone 45;grey limestone 70.
129	Fresh	7	12	20	1	Brown clay, gravel 4;black limestone 60;grey limestone 75.
130	Fresh	12	16	20	1	Gravel clay 8;black limestone 45;grey limestone 79.
131	Fresh	10	14	12	1/30 min	Boulder,clay, gravel 13;limestone 50.
132	Fresh	21	25	8	3	Clay 10;gravel 27;black limestone 57;brown limestone 67;blue limestone 88;grey limestone 114.
133	Fresh	Flow	60	20	1	Black silt, muck, clay 32;grey sand, clay 41; grey limestone 61.
134	Fresh	7	20	10	2	Medium sand, clay, boulder 11;grey medium sand 28.
135	Fresh	27	75	20	1	Brown sand, gravel, boulder 38;grey sand, clay 51; brown sand, clay 73;grey clay, gravel 78;blue limestone 96.
136	Fresh	10	15	20	/45 min	Medium sand, gravel, clay 29;blue limestone 45; grey limestone 71;white limestone 83.
137	Fresh	19	100	30	1	Grey clay, stones 85;grey limestone 103.

Well Number	Quality	Static Level (ft)	Pumping Level (ft)	Test Rate (gpm)	Test Duration (hrs)	Geologic Log (ft)
138	Fresh	21	90	30	1	Brown clay, stones 20;grey clay 55;brown sand, muck,gravel 65; grey clay 87;grey limestone 91.
139	Fresh	13	57	5	3	Brown clay 12;grey clay, boulder 36;brown medium sand 42;white clay, gravel 45;red clay 49; grey clay, gravel 57.
140	Fresh	8	15	30	/30 min	Topsoil,clay, medium sand 35;medium sand, gravel 65;shale 67.

APPENDIX B: References

REFERENCES

1. Rural Servicing Study, Regional Municipality of Halton, Underwood McLellan Limited, 1979.

2. Water Well Records for Ontario, Regional Municipalities of Halton and Peel, 1946-1974, Water Resources Bulletin 2-21, Ontario Ministry of the Environment, 1978.

3. Hydrogeology and Groundwater Model of the Blue Springs IHD Representative Drainage Basin, Water Resources Report 10, Ontario Ministry of the Environment, 1978.

4. Geology and Water Resources of the East and Middle Oakville Creeks IHD Representative Drainage Basin, Water Resources Report 12, Ontario Ministry of the Environment, 1979.

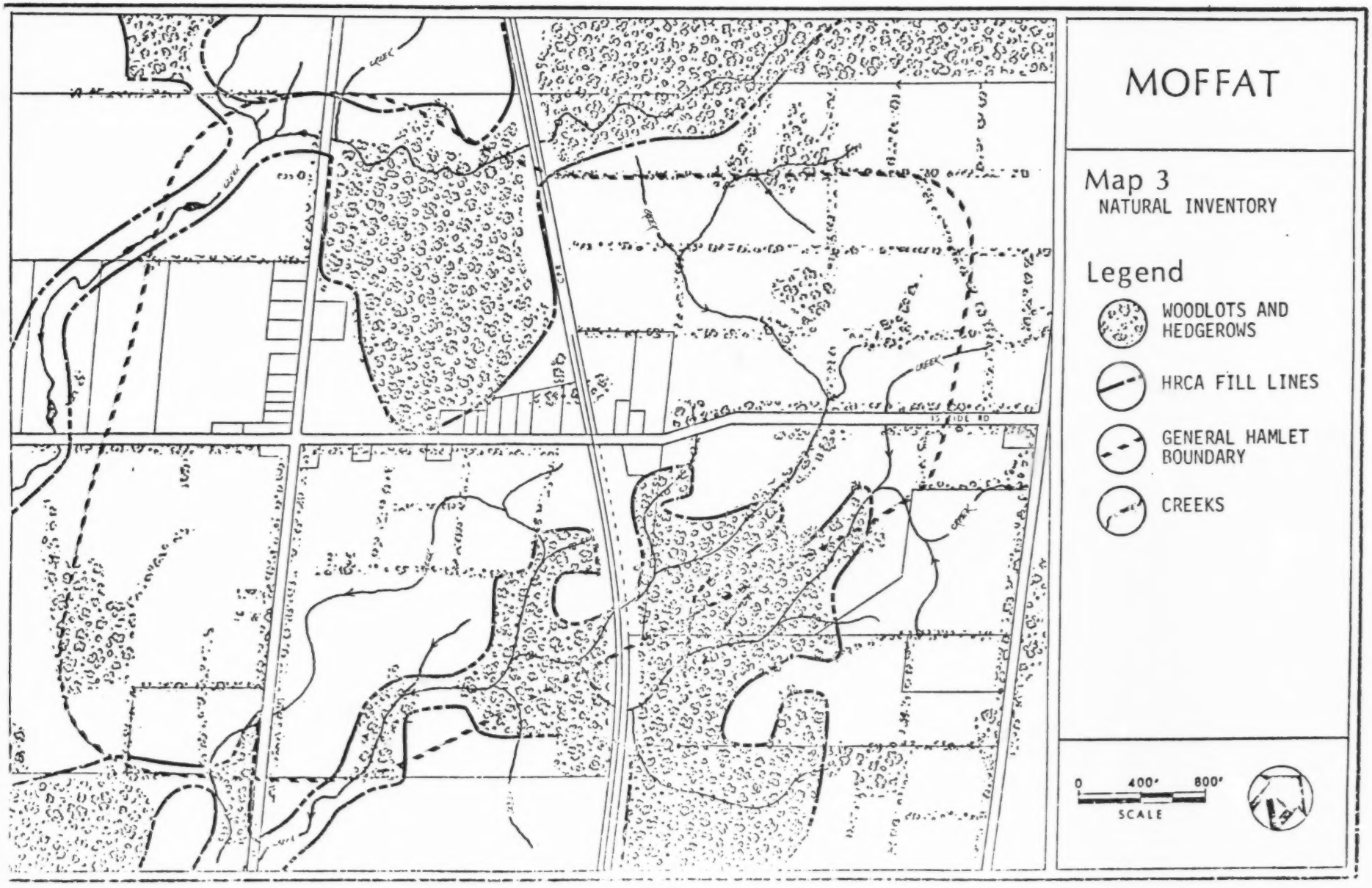
5. Pleistocene Geology of the Hamilton-Galt Area, Geological Report No. 16, Ontario Department of Mines, 1963.

6. Pleistocene Geology of the Guelph Area, Geological Report 61, Ontario Department of Mines, 1968.

7. Bedrock Geology of Toronto-Windsor Area, Map 1263A, Geological Survey of Canada, 1969.

8. Soils of Halton County, Soil Survey Report No. 43, Ontario Department of Agriculture, 1971.

APPENDIX C: Terms of Reference


MOFFAT
Map 3
NATURAL INVENTORY
Legend
WOODLOTS AND HEDGEROWS
HRCA FILL LINES
GENERAL HAMLET BOUNDARY
CREEKS
0
400'
800'
SCALE

REGIONAL MUNICIPALITY OF HALTON

PUBLIC WORKS DEPARTMENT

TERMS OF REFERENCE

HYDROGEOLOGICAL INVESTIGATION FOR THE HAMLETS OF

1. BROOKVILLE - PROJECT NO. PR-665
2. MOFFAT - PROJECT NO. PR-666

A. INTRODUCTION

The purpose of the Study is to determine the adequacy of long term groundwater supply to support new development in the Brookville and Moffat Secondary Plan Areas indicated on the enclosed plans without detriment to existing ratepayers. As the findings of this study will provide an input into the decision making process relative to future growth, it is important that information, upon which the recommendations are based, be as accurate as is practical.

B. TERMS OF REFERENCE

1. The Study will evaluate a water supply consisting of individual private wells to serve existing residences and future development.

2. Evaluation and comment on the existing wells will be necessary and the possibility of locating a communal supply of water to serve both existing and proposed development explored. Such evaluation shall advise on a program and probable cost to locate such a communal supply.

3. Contact Regional staff, Ministry of the Environment, and existing inhabitants, if necessary, to obtain current and past individual well water quantity and quality problems. Advise how future development will impact these wells and recommend solutions to this impact.

4. Advise the recommended minimum yield required for single family residences.

5. Advise the minimum size of lots in each area of future development with respect to groundwater availability.

6. Advise what phasing, if any, is required for future growth. One aspect of this may be that growth in certain locations may be permitted, while growth in other locations may be delayed, depending upon the impact that permitted growth will have on the aquifer(s).

B. TERMS OF REFERENCE (cont'd)

7. Recommend the necessary future test well construction and pumping, if this is required, to support the report findings.

8. Advise the well water quality that can be expected as well as quantity.

9. Evaluate the possible impact of septic tank system effluent from proposed developments on the groundwater supply.

10. The following meetings shall be considered to be part of this study:

    (a) Two meetings to review the draft report.

    (b) One public meeting.

11. The following are the number of copies of the reports that are considered to be part of this study:

    (a) Fifteen copies of the draft report.

    (b) Thirty copies of the final report.

12. The draft report shall be submitted to the Region for review six weeks after authorization has been given to start the study. The final report will be completed three weeks after comments to the draft report have been forwarded to the consultant.

MAP

FIRST LINE

FIFTEEN SIDEROAD

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GUELPH LINE
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LEGEND
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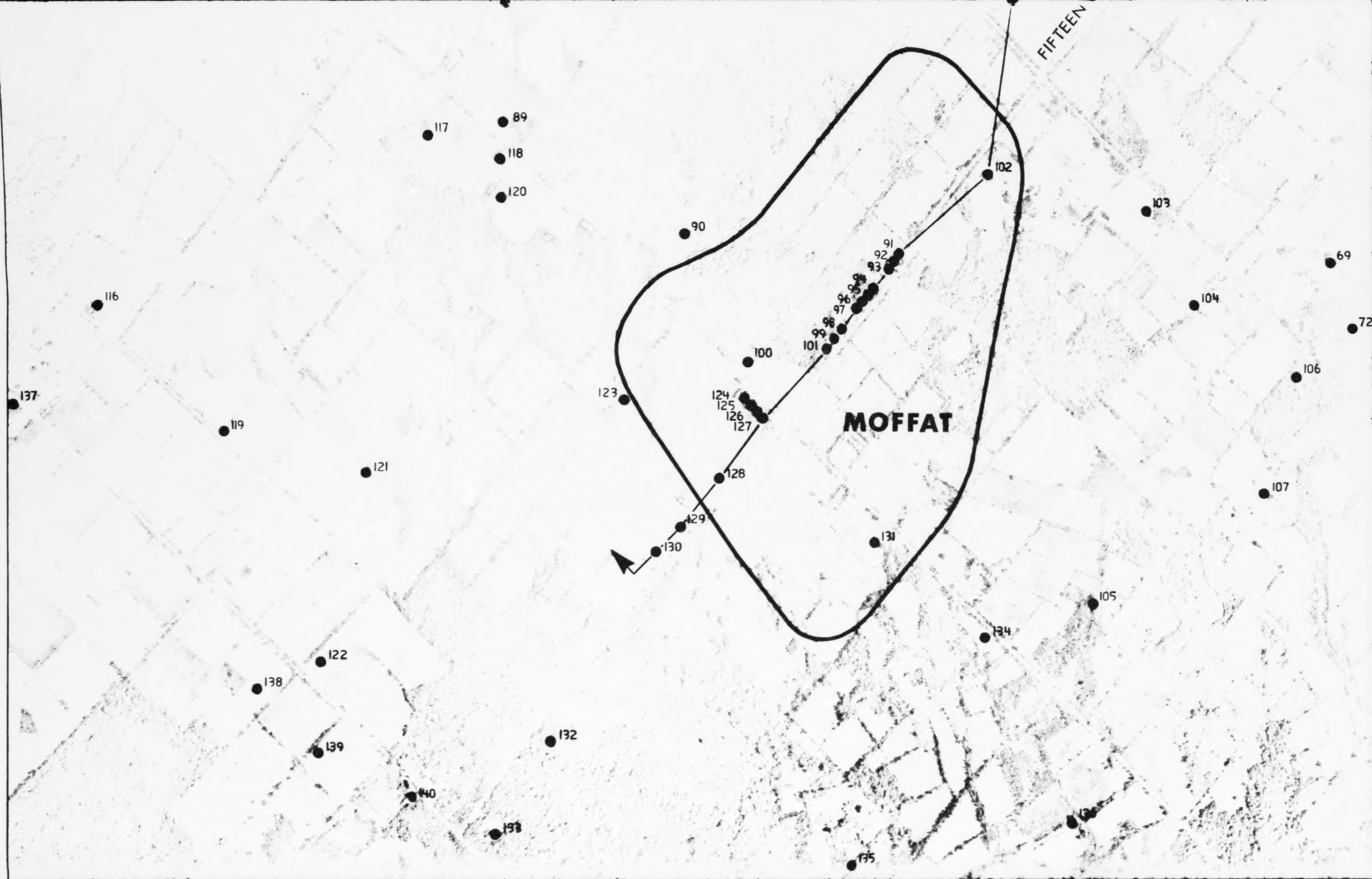
REPRESENTATIVE DRILLED WELL
LINE OF GEOLOGIC SECTION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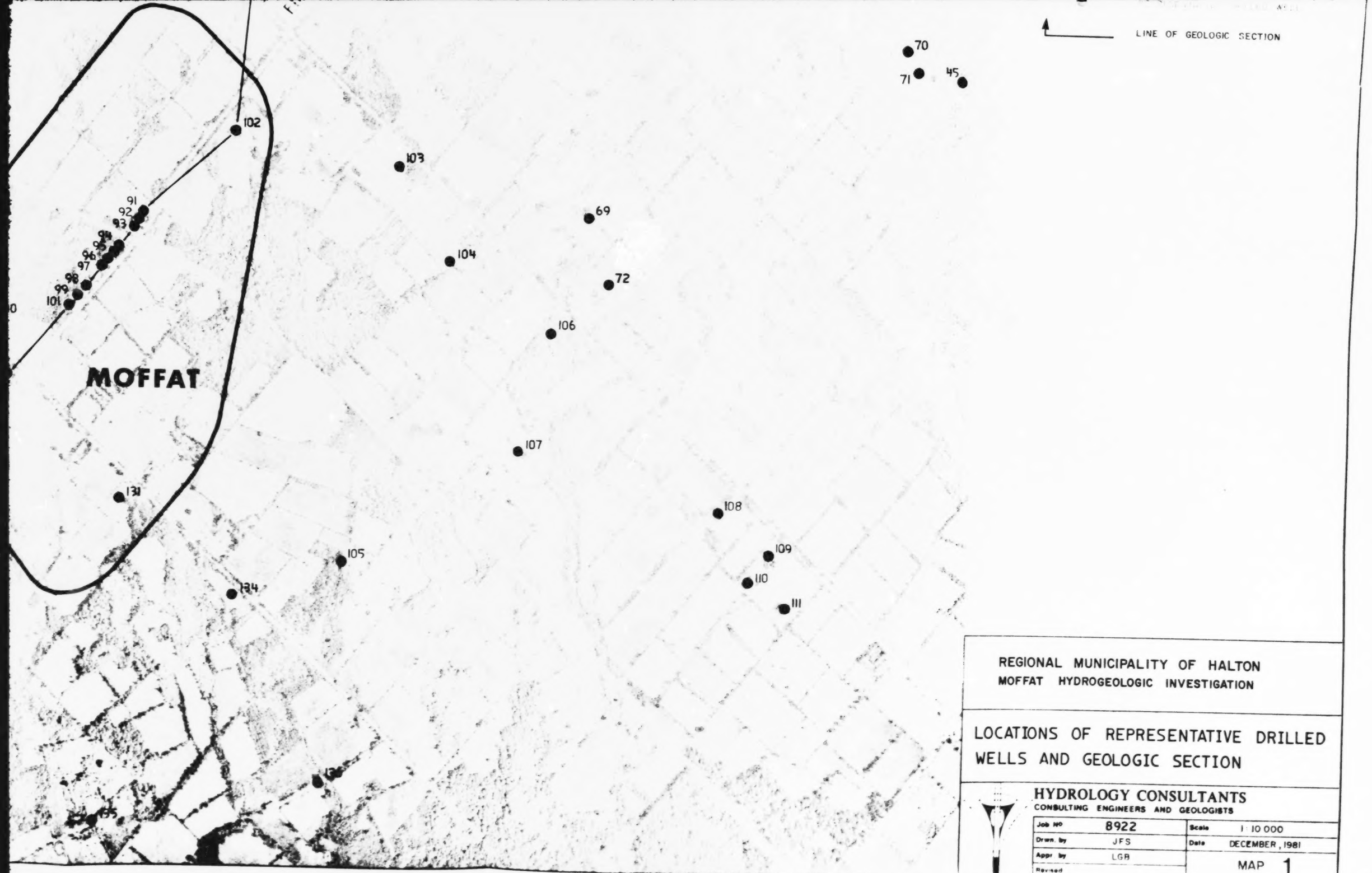

REGIONAL MUNICIPALITY OF HALTON
MOFFAT HYDROGEOLOGIC INVESTIGATION

LOCATIONS OF REPRESENTATIVE DRILLED WELLS AND GEOLOGIC SECTION

HYDROLOGY CONSULTANTS
CONSULTING ENGINEERS AND GEOLOGISTS

Job NO	8922	Scale	1 : 10 000
Drwn. by	JFS	Date	DECEMBER, 1981
Appr by	LGB		MAP 1
Revised			